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ARTICLE

A Phenomenology of the Present: Toward a Digital Understanding of *Gravity's Rainbow*

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This essay presents the results produced by the application of three corpus analysis tools to Thomas Pynchon's *Gravity's Rainbow*: word frequency/ keyness analysis, social network analysis, and topic modeling. It uses these data to argue that the novel is peculiarly concerned with the concept of the present moment. Engaging along the way traditional arguments about the nature of the book's Romanticism and its sense of "connectedness," the essay demonstrates how distant reading can aid us in perceiving aspects of overwhelming texts that are not easy to perceive otherwise, consequently complementing rather than opposing close reading practices.

In her digital analysis of Gertrude Stein's *The Making of Americans*, Tanya E. Clement concludes that such a long, complicated novel demands computerized study because trying to close-read its enormous, intricately-repetitive structure has "yielded limited material for scholarly work" (378). While Thomas Pynchon's *Gravity's Rainbow* may not be as viscerally resistant to normal reading as *The Making of Americans*, her general point—that digital tools can help us find patterns within extremely long texts that we would not otherwise see—still applies.[1] Outside of Luc Herman, Robert Hogenraad, and Wim van Mierlo's 2003 analysis of language related to the novel's "night journey" structure and Martin Eve's Textplot analysis, there have been no direct digital analyses of the book, though several quantitative analyses have been devoted to extra-textual materials such as the book's Amazon reviews (Ketzan) and wiki edits (Rowberry). However, as Christos Iraklis Tsatsoulis has recently shown regarding *V.*, digital tools can help us articulate a variety of lexical patterns within Pynchon's work. In this paper, then, I would like to further the project of bringing digital analysis to studies of Pynchon's work by applying several digital tools to *Gravity's Rainbow*.

For any experiment, a researcher can take two approaches: design a specific method to answer a particular question, or apply several established methods to see whether any interesting results are produced. Herman, Hogenraad, and van Mierlo approached *Gravity's Rainbow* in the former manner. I will follow the latter, employing word frequency, social network analysis, and topic modeling to *Gravity's Rainbow*'s text. That said, the results of my three experiments happen to suggest a loose argument: namely, that *Gravity's Rainbow* is unusually invested in a phenomenology of the present moment, especially regarding the tension between the respective concepts of the present moment as a purely contingent, momentary experience and as an eternal pattern underlying apparently changing circumstances.

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[1] Thanks to Jeffrey Binder, Mike Black, Kathleen Carley, Luc Herman, Brian Hirshman, Christos Tsatsoulis, and Ted Underwood for providing assistance with this project.
My book *The Cruft of Fiction: Mega-Novels and the Science of Paying Attention*, due out next summer from the University of Nebraska Press, addresses the cognitive difficulties posed by the excessive text of mega-novels in more depth.

Preparation

Prior to analysis, I prepared a plain-text file for each of the book's seventy-three sections. For the sake of my tools, this required removing all line-ending hyphens from the original text and converting em-dashes into double-hyphens. I also removed all diacritical marks, as they caused the tools to break words including them in two: this means we lose the distinction between Minnie Khlaetsch's accidental cry of "Hubschrauber" (i.e., "helicopter") and her intended "Hübsch Rauber" (i.e., "cute thief") (697), but there is otherwise no substantial problem. All other nonstandard characters—the θs, the mandalas, the pointing finger, etc.—were left as they stood, and the tools generally ignored them.

Tool 1—AntConc (Word Frequency and Keyness)

I began with one of the oldest forms of corpus study, word frequency. This method can be traced as far back as the medieval concordance, but its computational use in modern literary studies is usually rooted in the work J. F. Burrows, whose 1987 *Computation Into Criticism* distinguished the idiolects of Jane Austen's characters' via the frequency with which they use English's thirty most common words. High-frequency word distribution has since been used to address authorship questions (e.g., Holmes and Forsyth), as well as subtler problems in interpretive stylistics (e.g., Hoover). The deployment of lower-frequency words can be examined by calculating their *keyness*, or their over-or under-representation with respect to a control reference corpus, as with Paul Baker's study of verbs and adjectives relatively common in gay (e.g. *grunted*) versus lesbian (e.g., *giggled*) erotica (350).

To examine word frequency in *Gravity's Rainbow*, I loaded the text into AntConc, a corpus analysis tool created by Laurence Anthony. For my reference corpus, I used the Brown University Standard Corpus of Present-Day American English, a million-word "snapshot" of written American English as it was used in 1960 across multiple genres (e.g., novels, newspapers, scholarship, etc.). I chose this corpus because, if we accept Herman and Steven Weisenburger's claim in Gravity's Rainbow*, Domination, and Freedom* that the novel is part of a Long Sixties rebellion against mainstream culture, this corpus provides an empirical baseline establishing what that culture's

writing looked like. I compared the novel's text with both the entire corpus and its smaller fiction subset.

Once we skip past obvious high-frequency and high-keyness words (e.g., *Slothrop*), there are some unexpectedly frequent words.[2] For instance, several high-keyness words are common contractions, like *don't*, *it's*, *he's*, and *can't*. This should remind us of how unusually informal is Pynchon's narration compared to earlier literary fiction. When the fiction texts in the Brown corpus use contractions, it is almost always in dialogue, following the era's injunction to avoid contractions in formal writing (e.g., Sledd 332–333). In *Gravity's Rainbow*, though, contractions often appear in the voice of the narrator, as in the early line, "The Evacuation still proceeds, but it's all theatre. […] Above him lift girders old as an iron queen, and glass somewhere far above that would let the light of day through. But it's night" (3). From our contemporary view-point, where contractions are more common in fictional narration, this subtle but significant stylistic difference between Pynchon and his contemporaries can be easy to forget or overlook.

More interesting results emerge when we exclude the contractions and character names. The following tables (see **Table 1**) list the remaining top thirty words by keyness, with respect to both the full corpus (K1) and the fiction corpus (K2).[3] We will focus principally on the words appearing in both lists (those in bold), since words on K1 but not K2 might be specifically literary language (e.g., the second-person address common in dialogue) and those on K2 but not K1 might treat contemporary situations in which the fiction writers selected for the Brown corpus happened not to be interested (e.g., Germany, whose deteriorating political situation American news-papers covered extensively in 1960). Sixteen words appear on both lists, seven of which are nouns or adjectives that have been treated at length as semiotic keywords by Pynchon critics already: *rocket, zone, white, shit, light, sky, wind*. Three more are further examples of Pynchon's unusually informal diction: *sez, oh, ha*. The remaining six—*here, now, inside, knows, all, comes*—require further discussion.

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[2] Keyness was calculated using a standard log-likelihood test for one degree of freedom. This was cho-sen over a chi-squared test because word frequency does not resemble a normal distribution.

[3] All of these words' keyness are well above the 99.99% confidence level of 15.13 (i.e., p<0.0001).

	Full Corpus (K1)				*Fiction Corpus (K2)*		
Rank	**Freq.**	**Keyness**	**Word**	**Rank**	**Freq.**	**Keyness**	**Word**
1	2419	873.568	You	1	3297	1114.168	is
2	929	725.823	here	2	1001	555.609	has
3	1693	687.161	Out	3	1410	488.17	are
4	265	670.708	rocket	4	265	291.229	rocket
5	1171	592.731	now	5	258	187.861	comes
6	891	509.631	down	6	929	185.358	here
7	346	499.882	oh	7	9307	185.053	of
8	879	453.405	back	8	725	178.972	will
9	160	421.482	shit	9	160	157.856	shit
10	503	414.05	white	10	503	149.637	white
11	337	391.244	inside	11	129	147.366	sez
12	1315	380.938	up	12	216	143.056	knows
13	1800	363.391	all	13	126	133.922	zone
14	129	351.413	sez	14	745	133.593	can
15	355	351.097	black	15	175	119.925	goes
16	211	335.426	sky	16	170	118.47	german
17	497	331.459	away	17	6492	118.182	in
18	258	292.345	comes	18	299	115.479	among
19	126	283.759	zone	19	1171	104.639	now
20	686	281.323	just	20	84	95.959	ha
21	582	271.968	know	21	211	95.809	sky
22	216	270.66	knows	22	1800	95.721	all
23	390	268.527	light	23	176	89.216	wind
24	251	268.291	yes	24	75	85.678	cannot
25	1105	263.169	into	25	337	85.229	inside
26	176	240.254	wind	26	390	82.725	light
27	1612	239.136	her	27	346	81.778	oh
28	525	237.28	come	28	462	79.638	these
29	84	218.225	ha	29	94	76.104	feels
30	397	217.219	night	30	79	74.82	begins

Table 1: Keyness Measures for Gravity's Rainbow.

To understand their role in the novel, we should first notice that the top three words on K2 are common copulative and auxiliary verbs. Why should that be? How could *is*, *has*, and *are*—already extremely common English words—be among the novel's three most over-represented? The answer lies in the fact that *Gravity's Rainbow* is written in the present tense. This may seem less unusual now than it did at the time of the book's publication. As William H. Gass famously bemoaned, the literary present tense became more typical after the rise of minimalism in the 1980s.[4] Almost all of the Brown Corpus's fiction excerpts, though, are written in the past tense. While criticism on *Gravity's Rainbow* has discussed its temporality quite a bit, much of that has been devoted to the stability of the book's event-sequence (see Tölölyan, Duyfhuizen), its chronotope (Kolbuszewska 117–148) and its hysteron proteron figure (Weisenburger, *Fables* 242–249). The book's present tense is relatively unexplored territory. Two of the six words above (*comes* and *knows*), consequently, are common present-tense verbs.

Let's look in more detail, though, at the uses of *here* and *now*, given that the two are roughly as important to the novel, statistically, as *rocket*. Eight of the eleven chapters in which those words are most frequently used are set in the Zone. The scene in which Slothrop meets Geli Tripping might suggest why. Geli explains the Zone's *ad hoc* environment by telling Slothrop, "It's so unorganized out here. There have to be arrangements. You'll find out," and soon after, Slothrop "falls asleep, *presently* [emphasis mine], in [Geli's] bare and open arms" (299). The Zone, according to Geli, is defined by a utopian presentism, one whose reduction of spatiotemporal bounds down to day-to-day living seeks to shut out the Great Power jostling and longstanding ethnic hatreds that had caused the war in the first place.

The novel's critics generally assent to this live-for-the-moment sensibility. In an early essay, for instance, George Levine suggests he prefers to "trust the moments [rather] than any ideas I might invent about them" in reading *Gravity's Rainbow* (125), so that we may be, in Webley Silvernail's words, "simply here, simply alive" (135). This valorization of the present moment might best be evoked in Leni Pökler's

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[4] I discuss this subject at greater length in my review of *Bleeding Edge.*

rhapsody regarding "the level you reach, with both feet in, when you lose your fear, you lose it all, you've penetrated the moment, slipping perfectly into its grooves," an experience she tries to explain to her husband Franz as "as Δt approaching zero, eternally approaching" (161). Δt, of course, derives from the Newtonian approximation of an infinitesimally small unit of time, meant to deal with the Eleatic problem of how to describe the rate of change at the present moment.

There is a dark side to the present, though. The chapter featuring the most uses of *here* and *now* is the second section of Part 3, featuring Slothrop's journey into the tunnels beneath Dora. Slothrop's escape from Major Marvy through the Dora tunnels features a different kind of present: "With only that warning, in blinding concussion the Icy Noctiluca breaks, floods through the white tunnel. For a minute or two nobody in here can see. There is only the hurtling on, through amazing perfect whiteness. Whiteness without heat, and blind inertia: Slothrop feels a terrible *familiarity* here, a center he has been skirting, avoiding as long as he can remember" (316). This moment of reduction to present sensation, with both the place toward which he is headed and that from which he has come obscured, is not liberating for Slothrop but profoundly destructive. This may be why the novel's later references to Δt invoke not transcendence but dread, such as the narrator's comments about being hit by lightning: "do you know what the time rate of change *is* at a cusp? *Infinity*, that's what! A-and right across the point, it's *minus* infinity! How's *that* for sudden change, eh? Infinite miles per hour changing to the same speed *in reverse*, all in the gnat's-ass or red cunt hair of the Δt across the point" (677).

The novel, consequently, puts pressure on the question of what constitutes an adequate understanding of the present. Kurt Mondaugen's Law that "Personal density […] is directly proportional to temporal bandwidth" defines the latter as "the width of your present, your *now*. It is the familiar 'Δt' considered as a dependent variable. […T]he narrower your sense of Now, the more tenuous you are. It may get to where you're having trouble remembering what you were doing five minutes ago, or even—as Slothrop now—what you're doing *here*" (517; both emphases in the original). As if expanding upon the contemporary neuroscience result that our brain must integrate past stimuli into its perception of the present to allow us to

conceive motion (Armstrong 100), Mondaugen's Law implies that living fruitfully in the present moment does not merely entail sheer horizon-narrowing, but requires the temporal breadth that Zonal reductionism attempts to evade. As we might see by looking into any number of scenes in which the novel's questing heroes attempt to approach the Real—Slothrop at Peenemünde, Tcitcherine encountering the pointing finger— the novel's language points toward a dialectical conception of the present, not an affirmation of instantaneity: it is no coincidence that *here* and *now* frequently appear in the ngrams *here and there* and *now and then.*

Interestingly, the three chapters outside the Zone that most frequently invoke *here* and *now* have something in common: each is focalized, at least partly, around Dr. Edward Pointsman. That may be surprising, since Pointsman is not usually grouped among the novel's utopians. But as I have written elsewhere, Pointsman has more in common with Slothrop than we might like to think ("The Character…"). During the book's first third, it is he who takes most seriously the problem of the present. Pressured to put together some kind of plan for countering the existential threat caused by the V2s—an explicitly temporal problem, since the rockets arrive before their attendant sound—he often speaks urgently of the present moment while at his work ("tug now, hard as ever you can" [44]; "For God's sake, Mexico, slowly now" [46]) and constantly finds himself contemplating the relation of time to mortality. When his colleague Thomas Gwenhidwy suggests that the denizens of the White Visitation are all Jews during their Christmas party, Pointsman ponders:

> He means alone and forever separate. Pointsman knows what he means. So, by surprise, something in him is touched. He feels the Christmas snow now at crevices of his boots, the bitter cold trying to get in. […] Gwenhidwy, a million ice-points falling at a slant across his caped immensity, looking so improbable of extinction that now, from where it's been lying, the same yawing-drunk chattering fear returns, the Curse of the Book, and here is someone he wants, truly, with all his mean heart, to see preserved… (173)

If the novel is principally concerned with coming into knowledge of the here and now, its efforts begin in earnest with Pointsman.

Interestingly, none of Part 4's chapters are among those to most prominently feature *here* and *now*. The subject isn't entirely dropped, though. Consider the final passage:

> And it is just here, just at this dark and silent frame, that the pointed tip of the Rocket, falling nearly a mile per second, absolutely and forever without sound, reaches its last unmeasurable gap above the roof of this old theatre, the last delta-t.
>
> There is time, if you need the comfort, to touch the person next to you, or to reach between your own cold legs . . . or, if song must find you, here's one They never taught anyone to sing, a hymn by William Slothrop, centuries forgotten and out of print […]
>
> Now everybody — (775–776)

The problem of the present here draws everything back together again, the final depiction of the present moment simultaneously invoking community and destruction.

Tool 2—Automap/ORA (Social Network Analysis)

The next step in investigating the novel's treatment of the present is a social network analysis. Social network analysis has recently been popular in literary theory, given the longstanding interest in the way literature models social connections (see Elson, Dames, and McKeown; Moretti 211–230). *Gravity's Rainbow* may not be a work of social realism, but it is a book about connectedness, as shown in the narrator's claim that paranoia is "the leading edge of the discovery that *everything is connected*" (717). Furthermore, though some social network studies map the changes in relationships over time (e.g., Sack), for the most part, as Franco Moretti notes, social networks are "time turned into space" (215): that is, they collate all the complex interactions that happen over time and plot them into an image that may be perceived instantaneously. In other words, the ethos of connectedness espoused both by the narrator and the social network is one where everything exists in a single present. That kind of a present, though, is dialectically-opposed to the concept of presentness to that we emphasized in the previous section: instead of pure contingency, it perceives a

never-changing structure that is perpetually enacted. That view of an eternal present has also recurred in criticism on *Gravity's Rainbow*. Kathryn Hume, for instance, suggested that time in the Zone is perceived "more in cyclical than linear fashion" (40). It also resonates, more ominously, in the book's Nazi architect Etzel Ölsch, who constructs a nationalist worldview around rocket parabolas and the spatialization of time: "in the dynamic space of the living Rocket, the double integral has a different meaning. To integrate here is to operate on a rate of change so that time falls away: change is stilled . . . . 'Meters per second' will integrate to 'meters.' The moving vehicle is frozen, in space, to become architecture, and timeless. It was never launched. It will never fall" (305). A social network analysis, then, might provide an opportunity to address the tensions within the book's view of the eternality of the present.

To analyze *Gravity's Rainbow*'s social network, I loaded the chapter files into Automap, a social network tool created by Kathleen Carley, and visualized the results in ORA. Using Steven Russillo's online index of proper names in *Gravity's Rainbow* and Weisenburger's *Companion*, I compiled a master thesaurus of all the book's characters.[5] Of course, given the book's barrage of ephemeral personae (e.g., its references to film stars, contemporary politicians, distant relatives of supporting characters, etc.), including every properly-named person was infeasible, so I decided to count as a character (or, in network parlance, a "node") only named individuals who spoke dialogue, performed an action in a physical or imagined scene, or was introduced fictionally for the purpose of motivating action. This meant that I excluded most of

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[5] This required listing all the names by which all characters are called. The task proved difficult. I created separate files for chapters in which it was necessary to disambiguate between characters who shared a name (e.g., Richard M. Zhlubb and Richard Hirsch) or had a common English word for their name (e.g., the Herero named Christian). Amidst this enormous dataset, of course, there were a million tiny bugs, and I am not sure I caught them all: it took me a long time to realize, for instance, that Margherita Erdmann's lover Rollo was getting conflated with Rollo Groast, or that Laszlo Jamf's Osmo-elektrische Schalterwerke was being coded as Lord Osmo Blatherard. The most serious problem that I could not fix derives from the problem that some characters are referred to in different places by either their first and last names, requiring separate entries for each: that meant that, any time their full name is listed, they are double-counted. This mostly affects Slothrop, but it occasionally affects other major characters, like Pirate. I could not come up with an effective way to counteract this issue. I can only say that I believe that this glitch occurs infrequently enough that it affects the data in a minimal way that does not affect the general results.

(but not all) Slothrop's doomed conquests and ignored all but the most important real-world figures (e.g., Walter Rathenau and August Kekulé) and non-human agents (e.g., Octopus Grigori and Byron the Bulb). This yielded 260 distinct characters.

There is, as yet, no standard criterion in literary studies regarding what should constitute a connection for social network purposes.[6] Since the idea of "connected-ness" implied by *Gravity's Rainbow*'s narrator is a broad one, I linked all nodes whose names were mentioned within a four-sentence radius. This method is imprecise—for instance, it is not adequate for processing pronouns—but on a chapter-by-chapter basis, it seemed to adequately determine which characters had relationships and which did not.[7] It also has the advantage of weighting the edges and creating a useful multiplier effect for extended interactions: for example, if two characters were each mentioned three times in a four-sentence sequence, Automap would record nine separate connections between them.

Our first question—is *everything* really connected? No, in fact (see **Figure 1**). There are five isolates whose names do not appear within four sentences of anyone else's (e.g., the Raketen-Stadt tour guide Mindy Bloth), as well as two dyads who are only connected to each other (e.g., the *Rücksichtslos* crewmen Steve and Charles). Of course, this claim is somewhat spurious, as it depends entirely on my four-sentence parameter: were the search radius increased, these outcasts could be linked back into the network, and were it decreased, more nodes would be disconnected. This should illustrate, though, a point I've made elsewhere: the statement "everything is connected" is essentially meaningless, because if you lower your threshold for

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[6] Moretti and Dames both use inter-character dialogue, but others code different types of edges to represent whether a relationship is based on, say, interaction or observation (e.g., Agarwal et al.) or on bonds of friendship or enmity (e.g., Sack). Unfortunately, this divergence will likely prevent Moretti's dream of establishing a giant database of literary networks to allow broad cultural comparisons (240). It would make no sense, for instance, to compare my network of *Gravity's Rainbow* to his of *Story of the Stone*, given our different criteria regarding what constitutes a connection.

[7] I removed all ellipses, because the software coded them as three distinct sentence-breaks, though that caused its own problems. I will stipulate that a different scholar, using different pre-processing methods, making different decisions about what characters to include, and falling prey to different errors, would produce different raw numbers. I advise, then, that readers pay more attention to the relative position of different characters on these measures rather than the numbers themselves.

Figure 1: Gravity's Rainbow: Complete Character Network.

connectedness sufficiently, you can connect anything to anything else. The real question is *how closely* everything is connected ("How Closely…").

That is a trickier subject. Luckily, network theory has tools for examining such questions. For example, here are four tables ranking the characters by different measures of centrality for each character (or "node," in network parlance). The first chart (see **Table 2**), which simply lists the number of times the character's name appears in the book, probably matches how most readers would rank the main characters' overall importance on a subjective basis: Slothrop is well in the lead, followed by secondary focal characters like Roger Mexico and Vaslav Tcitcherine. Yet on the second list, which measures the number of characters to whom each node has a link

Rank	Character	Node Freq	Rank	Character	Edges
1	tyrone_slothrop	1209	1	tyrone_slothrop	136
2	roger_mexico	278	2	edward_pointsman	44
3	franz_pokler	215	3	gerhardt_von_goll	42
4	vasla_tchitcherine	202	4	roger_mexico	39
5	edward_pointsman	179	4	pirate_prentice	39
6	blicero_weissmann	177	6	katje_borgesius	35
7	pirate_prentice	168	7	franz_pokler	33
8	gerhardt_von_goll	161	8	vasla_tchitcherine	30
9	oberst_enzian	157	9	laszlo_jamf	29
10	katje_borgesius	122	9	leni_pokler	29
11	seaman_bodine	98	11	carroll_eventyr	28
12	saure_bummer	97	12	margherita_erdmann	27
13	jessica_swanlake	94	13	blicero_weissmann	26
14	margherita_erdmann	92	14	oberst_enzian	25
14	tantivy_mucker-maffick	92	15	seaman_bodine	23
16	major_marvy	89	16	saure_bummer	22
17	klaus_narrisch	82	16	teddy_bloat	22
18	laszlo_jamf	79	16	bianca_erdman	22
19	lyle_bland	73	16	brigadier_pudding	22
20	miklos_thanatz	67	16	clive_mossmoon	22

Table 2: Gravity's Rainbow: Complete Network Node Frequency and Edges.

Rank	Character	Closeness	Rank	Character	Betweeness
1	tyrone_slothrop	0.66	1	tyrone_slothrop	0.575
2	gerhardt_von_goll	0.499	2	gerhardt_von_goll	0.065
3	edward_pointsman	0.482	3	pirate_prentice	0.064
4	laszlo_jamf	0.482	4	edward_pointsman	0.06
5	franz_pokler	0.478	5	franz_pokler	0.052
6	katje_borgesius	0.478	6	laszlo_jamf	0.049
7	roger_mexico	0.476	7	vaslav_tchitcherine	0.049
8	blicero_weissmann	0.467	8	leni_pokler	0.047
9	pirate_prentice	0.466	9	roger_mexico	0.04
10	margherita_erdmann	0.462	10	lyle_bland	0.038
11	leni_pokler	0.46	11	katje_borgesius	0.036
12	seaman_bodine	0.46	12	seaman_bodine	0.032
13	oberst_enzian	0.455	13	oberst_enzian	0.03
14	carroll_eventyr	0.455	14	margherita_erdmann	0.027
14	vaslav_tchitcherine	0.453	14	blicero_weissmann	0.025
16	nora_dodson-truck	0.453	16	spokesman	0.024
17	stephen_dodson-truck	0.452	17	carroll_eventyr	0.024
18	brigadier_pudding	0.45	18	saure_bummer	0.019
19	major_marvy	0.448	19	peter_sachsa	0.018
20	clive_mossmoon	0.447	20	malcolm_x	0.016

Table 3: Gravity's Rainbow: Complete Network Closeness and Betweenness Measures.

(or "edge"), the prime secondary characters change. Gerhardt von Göll springs from eighth to third, Laszlo Jamf rises from eighteenth to ninth, tied with Leni Pökler, who ascends from just outside the Top 20. Perhaps most surprising on this list is Carroll Eventyr, who barely cracks the Top 40 on raw frequency yet is just behind Leni and Jamf in edge count (or "degree"). Their rise comes at the expense of the secondary protagonists, who generally fall off.

Of course, degree on its own can be misleading. For instance, Pointsman's high degree is largely a function of the somewhat arbitrarily large number of hazily-sketched-but properly-named kooks who work at the White Visitation (Gwenhidwy, Silvernail, Milton Gloaming, Géza Rózsavölgyi, etc.), which may not tell us much

about the book's larger network. What we might want to know, instead, is who best connects the major subgroups. The next two charts—"closeness," which measures the average number of steps each character requires to get to each of the other characters in the network, and "betweenness," which measures, for a given character, what percentage of the shortest paths between all pairs of characters go through him or her—address that issue (see **Table 3**).[8] The results here, though, carry things along the same lines: von Göll flips with Pointsman into second place, Jamf rises even higher, and Mexico falls further.

How do these relatively minor characters overtake the main ones in their connectedness to the network? For von Göll— "the knight who leaps perpetually [...] across the chessboard of the Zone" (382)—the answer should be intuitive. He shows up peripherally in most of the Zone vignettes—the Argentine submarine, the Erdmann studio idyll, Bummer's dope mission, etc.—and his film about the Schwarzkommando draws interest at the White Visitation, making him an easy route between sub-networks. Jamf, similarly, is a sinister presence connecting the scientific and military institutions of Germany, Britain, and America. Eventyr and Leni Pökler may be more surprising, but their joint participation in séances allows them to connect the German and British military worlds to the world Beyond the Zero. Some other minor characters do markedly well on one measure, but not the other. Those who score well on closeness are well-connected to large sub-networks and major characters but have few outlets to the smaller subnetworks: the Dodson-Trucks, for instance, are thick with the Counter-Force but are no one's avenue out of that group. Those who score high on betweenness but not closeness, have few, but varied or exotic, attachments. Lyle Bland is the best example, as every route to his family (and many to the Slothrops) goes through him, and his connections to German scientists and the American government make him a potent go-between for multiple sub-networks.

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[8] To be precise, closeness is the inverse of the average number of steps: for instance, Slothrop's closeness of 0.66 means he has an average distance of 1.5 edges to each other character. These measures exclude the isolates and dyads. For this step, I binarized the network—that is, I treated the edges between character-pairs as equivalent and unweighted, no matter how many individual connections contributed to them.
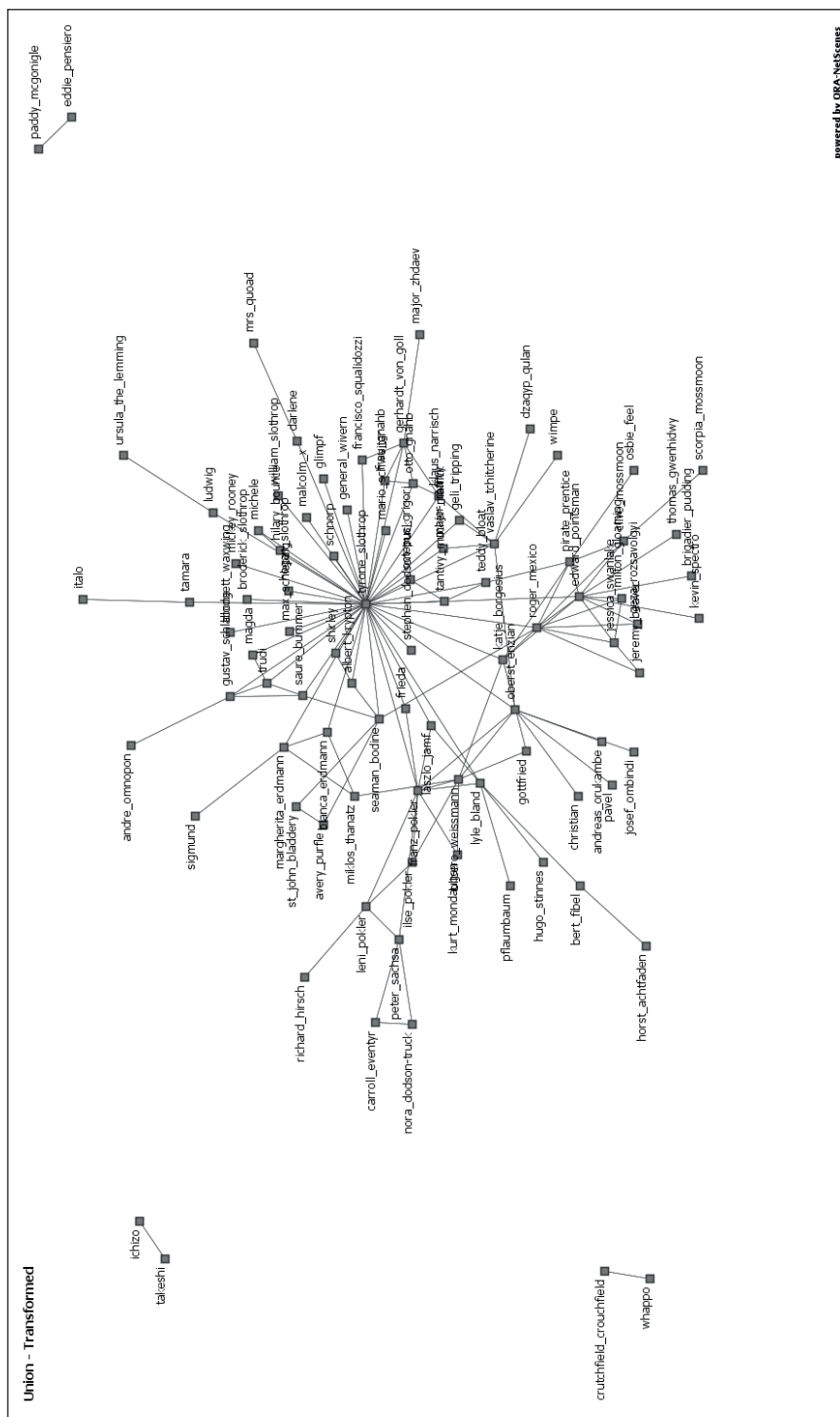
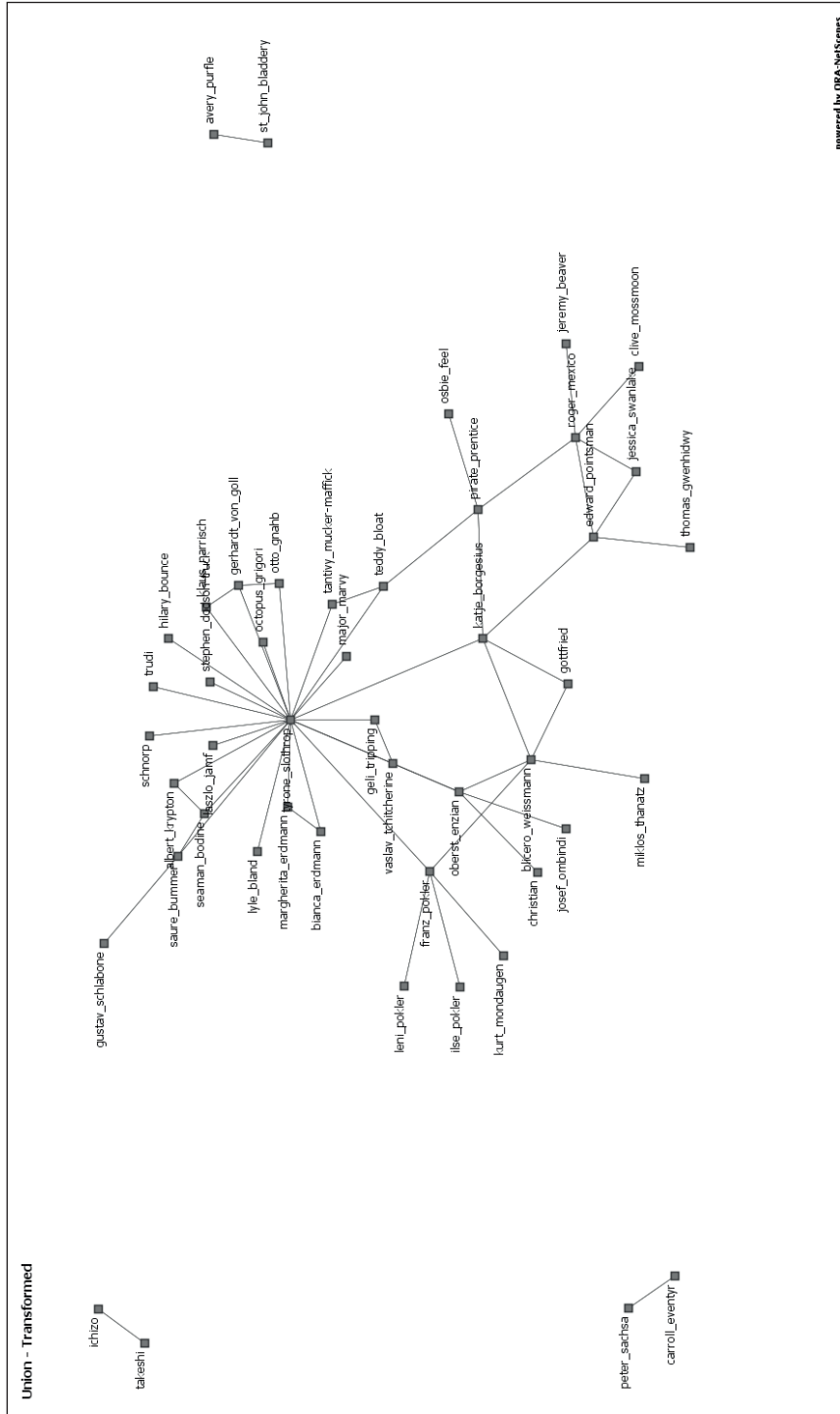**Figure 2:** Gravity's Rainbow: Major and Minor Relationship Network.

Figure 3: Gravity's Rainbow: Major Relationship Network.

In other words, many parts of the network are held together by relatively weak connections. To reinforce this point, observe what happens if we limit the display to only those edges representing at least ten connections. Von Göll and Jamf remain important, but Leni and Eventyr are banished to the periphery (see **Figure 2**). If we raise the bar again, to twenty, von Göll is marginalized and Jamf all but disappears, with Mexico, Tcitcherine, Enzian, Pirate, Blicero and Katje reemerging as more central characters (see **Figure 3**).

This finding resonates with another highly influential vision of connectedness that, coincidentally, was also published in 1973: sociologist Mark S. Granovetter's "The Strength of Weak Ties." Granovetter argues that, since the strong ties in a network will tend to create weak ties between nearby nodes, weak ties essentially act as shortcuts across networks, and "whatever is to be diffused can reach a larger number of people, and traverse greater social distance (i.e., path length), when passed through weak ties rather than strong" (1366). Pynchon appears to have intuited this result: only four of Jamf's twenty-nine edges have more than five connections, and for Eventyr it's three of twenty-eight. (By contrast, of Roger Mexico's thirty-nine edges, fourteen have more than five connections.) Von Göll and Leni may not appear to fit this pattern, as they have a number of strong ties, but it's their weaker ones (to Bland, Pirate Prentice, Geli Tripping, and the Argentines for the former; to the Erdmanns, the German military, and the crowd at Putzi's for the latter) that are more important to their network centrality.

So we have a handful of traditional major characters, alongside a group of minor characters who are at least as effective (and sometimes more so) in connecting the various subnetworks. I would argue that the relationship between these characters enacts the tension between the contingent and eternal present that I've articulated. The former group includes most of the novel's focalizers, those through whom time in the novel is experienced and who, consequently, tend to be those through whom the experience of a contingent present is generally articulated. The latter, though, tend to distort time and provide intimations of an eternal, inescapable temporal structure underneath, whether benevolent or malevolent: Jamf's work destabilizing cause-and-effect through synthetic conditioning, Eventyr's work speaking to the

dead, and von Göll's cinematic manipulations produce a sense that there is some larger structure through which apparently random events are controlled.[9]

The character on whom that pressure is most acutely felt, of course, is Slothrop. It may not seem surprising that Slothrop is the top character by far on each measure: he is, after all, the protagonist. Yet his position in the network also turns one of the most frequent commonplaces regarding the book against itself. The most-used measure of a network's reliance on its central node is something called Freeman centralization, which measures the difference between that node's degree and that of all the other nodes. *Gravity's Rainbow* has 51% centralization, a high number, reflecting the fact that most of the characters are connected to Slothrop and many of them only have a few edges otherwise. Yet much criticism on the novel has claimed, as Brian McHale does, that "[i]f decentered subjectivity is the postmodern condition, then Slothrop is its poster child" (100). The network, though, suggests the opposite, that Slothrop is a remarkably *centered* protagonist. Granted, the postmodern argument means something slightly different by "centered" than the social-network definition—referring more to Slothrop's interior instability rather than his external relationships—and it might even be argued the "decentered" argument aligns well with the way Moretti and other theorists consider a socially-centered protagonist like Slothrop not in terms of his "'consciousness' and 'interiority'" (218) but as merely a "function in the stability of the network" (222). Notice, though, how well these conflicting definitions of "centered," interior and world-contextual, align with the conflicting definitions of "present" we have laid out. As the key figure in both the narrative's focalization and its social network, Slothrop constitutes the fraught intersection of the book's conflicting temporal tensions.

Two more quick observations about the network before we move on. As we increase the threshold for edges, the network becomes ever more centralized on Slothrop, eventually yielding something resembling the classic star network. If we

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[9] As Pökler thinks upon analyzing film of rocket launches, "There has been this strange connection between the German mind and the rapid flashing of successive stills to counterfeit movement, for at least two centuries—since Leibniz, in the process of inventing calculus, used the same approach to break up the trajectories of cannonballs through the air" (413)
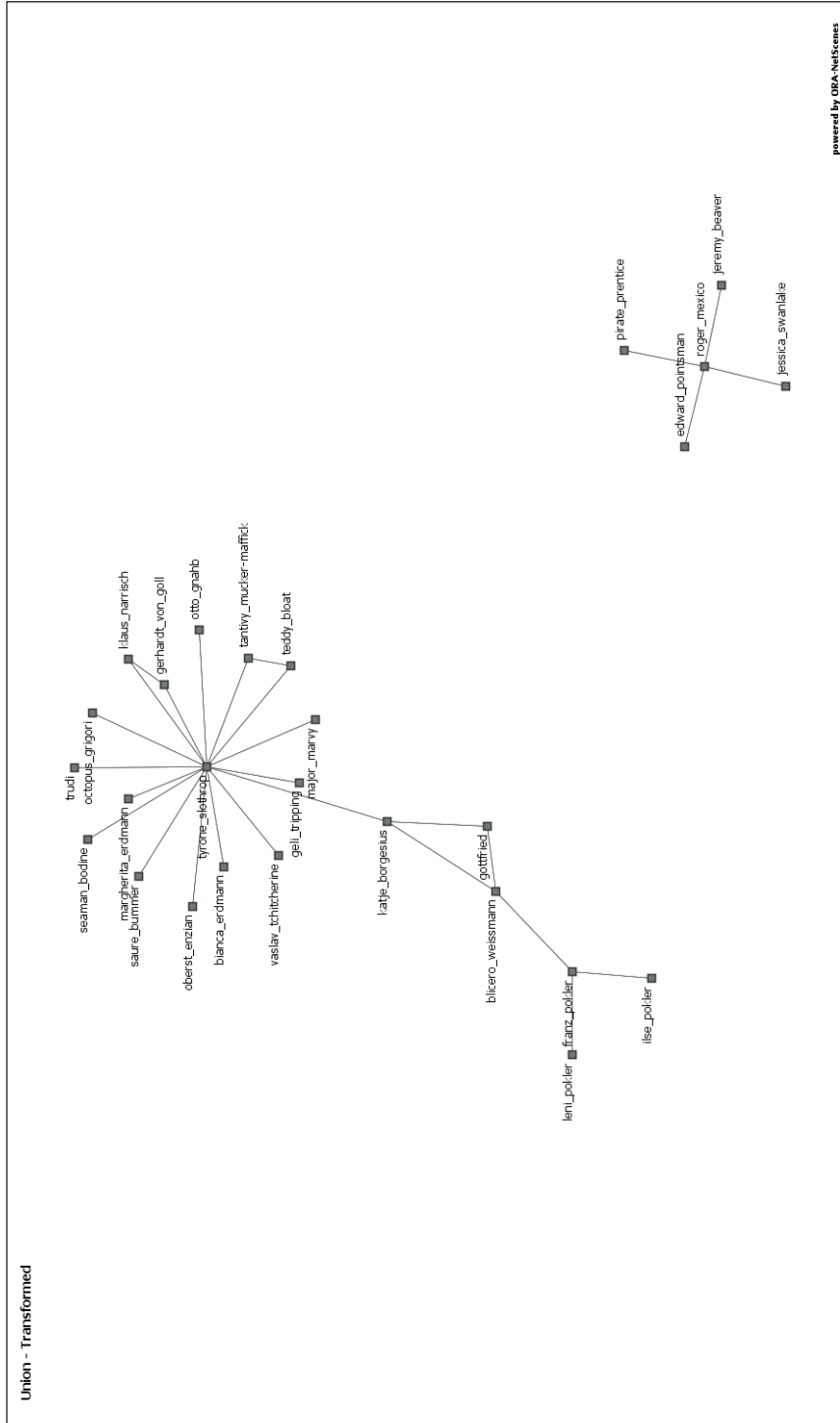
Figure 4: Gravity's Rainbow: Main Character Network.

raise the criteria to thirty-two connections, the only relationships that can stand with Slothrop's network are the adjunct Pökler-Weissmann-Gottfried dynamic and the secondary star around Mexico (see **Figure 4**). It is not until late in the book that Slothrop realizes "the Zone can sustain many other plots besides those polarized upon himself" (614), and the book's network reflects that egocentric view. There is, though, something interesting about Mexico's subnetwork. We usually visualize a MFM love triangle, like the Roger-Jessica-Jeremy one, as centered on the woman, yet *Gravity's Rainbow* emphasizes the Jeremy-Roger edge much more than Jeremy-Jessica. (It's not even close: Jeremy-Roger has forty-six connections and Jeremy-Jessica only fourteen.) We might consider this fact, along with the similar Slothrop-Geli-Tchitcherine triangle, corroboration for Eve Sedgwick's thesis in *Between Men* (building off René Girard) that "in any erotic rivalry, the bond that links the two rivals is as intense and potent as the bond that links either of the rivals to the beloved" (21).

Last, we might wonder which edge represents the book's single strongest bond. One of lust and domination, like Blicero's over Gottfried? Enmity, like that between Mexico and Pointsman? Family, like that joining the Pöklers? No, it's the one between Slothrop and his disappeared pal Tantivy Mucker-Maffick, which has 111 connections, and second place goes to Roger and Jessica's romance, with ninety-nine. Chalk one up for friendship and love—let it not be said the book doesn't have a heart.

I've attached the network's xml file to this article, inviting others to explore it further. For now, though, let's observe that the book complicates what may appear to be an emphasis on pure, simple moments experienced by focal characters. The kind of connectedness produced by its stealthy weak-tie brokers raises a very different notion of presentness, complicating those idyllic sentiments. It is the tension between those approaches that drives the book's engagement with temporality.

Tool 3—Topic Modeling

A social network might show us the ways in which the novel's characters are connected, but if we want to examine the connections among its broader semiotic patterns, we will need to use topic modeling. Developed by David Blei, topic modeling

is an ambitious process that assumes that any given set of documents is generated from a certain number of topics—each conceived as a distribution of word frequencies across the set's total vocabulary—using Gibbs sampling and Markov chains to approximate those topics. The results are usually interpreted by the researcher via examining the topics' most-frequent words. For example, a topic model trained on recent *New York Times* articles will likely identify topics related to the US government (e.g., possessing something like "president congress house obama supreme" as its most frequent words), local New York City government ("mayor city manhattan council deblasio"), the Middle East ("iraq syria muslim israel isis"), and the environment ("climate global change carbon warming"). An individual article on, say, American policy in the Middle East might have a high percentage of the first and third and very little of the second and fourth, while an article on a UN climate summit in New York may be led by the fourth with substantial amounts of the first and second and almost nothing of the third.

The most obvious applications of topic modeling for literature have been on paraliterary, multi-author datasets such as journal archives (e.g., Goldstone and Underwood). When it has been applied to fiction, it has been most frequently used with large corpuses, as with Matthew Jockers's work on a corpus of thousands of British novels (123–153). Yet some meaningful topic modeling has also been done on individual novels: for instance, Tsatsoulis found that a three-topic model provided an adequate stylistic basis for distinguishing the Stencil and Profane chapters of *V.* Since *Gravity's Rainbow* is concerned with the overlap of a wide variety of discourses, we might imagine that a topic model could chart the interplay between these subjects.

To produce the topic model, I loaded the chapter files into Andrew McCallum's MALLET, and after deleting the novel's apostrophes (which cause MALLET to break up words), I used the standard stop-word list and set MALLET to optimize hyperparameters (i.e., not assuming overall equality of topics). However, regardless of the settings I entered, MALLET's internal checker found that the distance between the model and the novel was minimized with a trivial 1-topic model, increasing indefinitely as the number of topics increased. I tried converting the chapters into 333

1,000-word chunks instead, but that proved no better.[10] This result, of course, makes perfect sense: MALLET has figured out that all the documents I gave it are part of the same novel! As Jockers reports, individual segments of a single novel have markedly more statistical affinity with each other than with chapters from other novels from the same era or genre (97). Topic modeling can be a powerful tool, but it relies on assumptions which may not be appropriate for a dataset such as chapters of a novel, especially given that it requires researcher inputs that cannot be externally validated.

I nearly gave up, concluding that this tool was not appropriate, but as I'd already sunk a fair amount of work into the project, I produced a topic model anyway. Any adequate topic model, I reasoned, would have to consistently generate topics that separated the distinct clusters of characters identified in the social network analysis. After experimenting with several models that met this criterion to different degrees, I settled on a 45-topic model, running it ten times with 1,000 iterations of the Markov chain. While these parameters produced a certain degree of stability—each had all but one or two of the fifteen character clusters I isolated—the topics produced by the ten trials differed noticeably. Independent topics from one trial would often combine with other topics in another—the top words in Run 8's Topic 23 involved Mrs. Quoad's candies, but in Run 6 they got lumped arbitrarily into Topic 22 with the Angel of Lübeck—or vanish entirely. The novel's aforementioned interconnectedness also proved to be a problem for making clean topic distinctions: for instance, Katje's high centrality to the network meant that in Run 3 several references to her ances-tor's role in the extinction of the dodoes got grouped with the Oven Game (Topic 13), while in Run 4 they wound up with the Counter-Force (Topic 43). In short, the overall experiment was too inconsistent to claim much in the way of global results.

Still, my 45-topic model did produce several consistent topics that I had not included in the premise. For instance, a topic I will call "German Film and Pornography" appeared in every trial, and while its exact composition differed each

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[10] The standard check on a model's accuracy is a log-likelihood score with respect to the initial text, though as Tsatsoulis notes, this is not a perfect method. Tsatsoulis ran into a converse but equally trivial result on *V.*, a minimized log-likelihood at 18 chapters, essentially just creating one topic for each chapter.

time, words like *film*, *watched*, *stockings*, *thighs*, *whip*, and *rack* frequently appeared alongside references to von Göll, Max Schlepzig, and the Erdmanns. Similarly consistent topics included "Rocketry" (*rocket*, *SS*, *oxygen*, *seconds*, *tail*, *fuel*, etc.), "Slothrop as American Everyman" (*slothrop*, *girls*, *American*, *hey*, *sez*, *bar*, *shit*), and "Life, Death, and the Beyond" (*death, dead, life, love*, *power*, *history*, *dream*). This last might provide some food for thought: it's interesting to see that abstractions as distinct as death, love, history, and dream are all quantitatively identifiable as part of the same discourse in the novel.

Still, one might look at these results and ask, "So what?" Everyone knows *Gravity's Rainbow* deals with those topics. I was ready to abandon the project, until I noticed something odd: the most common overall topic in each trial seemed to have *back* as its most frequent word. At first, these topics simply looked like random words the model couldn't fit anywhere else: out of context, Run 8's Topic 2, beginning "back white good head green hand great," looks fairly incoherent. Yet these words weren't getting grouped together by chance: in every trial I did, the most common topic looked roughly the same. I constructed the following top-twenty list from the ten trials, with each word appearing on at least four trials' most-populous-topic Top 20: "back white great black night head long green good time hand red kind side sky light dark eyes face day."

Is this interpretable? We have five body parts (*back*, *head*, *hand*, *eyes*, *face*); four colors, specifically two sets of opposite colors (*white*/*black*, *red*/*green*); some evaluative adjectives (*great*, *good*); and two oppositions relating to the Earth's natural rotation (*day*/*night*, *light*/*dark*), plus a fifth word indicating the medium in which those oppositions are perceived (*sky*) and a sixth that describes the more abstract process they indicate (*time*). We have, that is, a topic that includes the human body's major perceptual sites, several of the most frequently-troped natural objects of human perception, and a larger framework of opposition and abstraction that relates perception to broader philosophical universals.

Would it be appropriate, then, to label this discourse "Romanticism"? Friedrich Schlegel famously claimed Romantic poetry should fuse "the poetry of art" and "the poetry of nature," combining "the greatest systems" with particulars like "the sigh,

the kiss," moving "not only from within outwards, but also from without inwards" (175).[11] Pynchon critics have, of course, long talked about the Romantic strain in *Gravity's Rainbow*: the novel is loaded with references to German Romanticism and its legacy in the work of Richard Wagner and Rainer Maria Rilke. For some, the book is unabashedly Romantic, "expand[ing] conceptions of gravity which have been developed by post-Romantic philosophers of the nineteenth and twentieth centuries who responded to the Romantic radicals' traumatic recognition of gravitation as a demonic force" (Black 231), while others emphasize instead how the book's Romantics are "complicit in the march toward death" (Eve, *Pynchon* 40). But I'm not sure that anyone has gone so far as to argue that it's the novel's most central discourse, which is what this analysis suggests.

We should also observe how neatly this finding gels with our temporal analysis. More than any other intellectual tendency, Romanticism is obsessed with the problem of the present and its relationship to the eternal, generally believing that acute perceptions of one's present surroundings allow access to the infinite. Think of William Blake's "To see the world in a grain of sand/ […] And Eternity in an hour" (1, 4). Moreover, while the book's Romanticism appears important to nearly every chapter, its maxima occur at the beginning and end, which are the moments when the novel's time is most out of joint (see **Figure 5**): the initial rocket attack that arrives before it is heard and the lead-up to the second rocket that leaps in time from 1945 to the 1970s.[12]

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[11] Unfortunately, given the long-acknowledged difficulty in establishing a general definition of Romanticism, there is no agreement on what constitutes a Romantic discourse. That said, there may be some support for this interpretation in Ryan Heuser and Long Le-Khac's findings regarding their so-called "hard seed" vocabulary in the British novel. The "hard seed" is a cohort of words comprising body parts, colors, and physical adjectives/prepositions—that is to say, a set of words that overlap considerably with the topic in question from *Gravity's Rainbow*—whose frequencies are correlated and whose prevalence in British novels begins to increase steadily in the early nineteenth century (19–27). Heuser and Long attribute this rise to the increased physical description required by the urbanization of novelistic space and the decline of explicit narrative moralism (39–46), but we might as plausibly (and perhaps complementarily) speculate that the increase in the "hard seed" also represents the sensory zeitgeist of Romantic poetry gradually seeping into prose style.

[12] These were calculated by averaging nine of the ten runs. Run 5 was excluded as an outlier, as its version of this topic took up a far smaller proportion of the total text than any of the others.
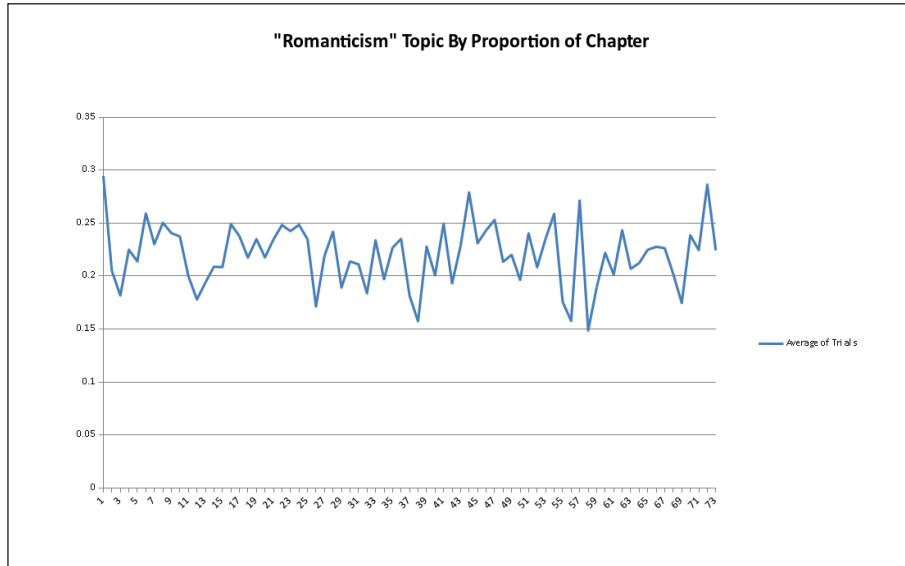
Figure 5: The Romanticism Topic.

Unsurprisingly, though, the book's Romanticism is wrapped up in paradoxes. Recall how the topic's most frequent word is *back*, not a quintessential Romantic word.[13] That peculiarity results from a verbal ambiguity that manages to encapsulate in microcosm the book's Romantic ambivalence. One of topic modeling's typical advantages over a regular keyword search is that it usually segregates different meanings of a word: for instance, if you wanted to create a corpus of newspaper articles about literature, you should not simply search for every document that used the word *book*, because you'd likely also pick up documents about reserving hotel rooms and incarceration; a topic model, by contrast, would isolate these distinct meanings into separate topics. Within *Gravity's Rainbow*, however, different meanings of *back* are revealingly conflated within the Romanticism topic.

According to the topic model, the most Romantic chapter between the novel's beginning and end is the forty-fourth, which does not feature a conventional experience of the sublime, instead depicting Slothrop's pedophilic encounter with Bianca. The word *back* is used many times in this passage, but in several different senses. Early

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[13] Eve's Textplot also shows back as an exceptionally important word within the novel's discourse.

on, its erotic meanings are emphasized, as when Bianca "lift[s] her dress, turn[s] so she can also watch Slothrop back over a shoulder" (476); as she approaches him, "[t]he bare backs of her legs come brushing softly across Slothrop's face" and "[h]er long hair falls to the level of Slothrop's eyes, fine and black, the split ends whispering across the small of her white back in and out of invisibility, like rain…" (477). This is *back* as pure sensuality, a sort of perverse version of the Wordsworthian "spot of time" that enables privileged access to natural beauty. However, after the two have sex, the uses of *back* immediately shift, with a befuddled Slothrop wondering, "What happened back there?" (478). *Back* begins to suggest not immersion in the present, but a broader temporal range that leads Slothrop away from Bianca. Remembering that he must continue toward his rendez-vous with von Göll, Slothrop deserts Bianca in the hold: "[s]traightening his bow tie, brushing off the satin lapels of his jacket, buttoning up his pants, back in uniform of the day, he turns his back on her, and up the ladder he goes" (478).

What can we make of this disturbing scene? On the one hand, Slothrop's long-term neglect of adult responsibility in favor of immediate carnality is surely abusive, yet his and Bianca's post-coital embrace, forgetful of the fraught history surrounding them, engenders his sole sense of her humanity, that "Right here, right now, under the makeup and fancy underwear, she *exists* […] For Slothrop this is some discovery" (478).[14] His subsequent denial of that sensual present in favor of his broader temporal progress—"coming back is something he's already forgotten about" (478)—subsequently dooms her, and his later attempts to "mentally bring her back" lead to his nagging awareness of a "Eurydice-obsession, this *bringing back out of…*" (480). There are no easy conclusions to be drawn from this scene, but amidst everything else, it highlights a tension within the Romantic worldview: one might believe one has grasped the world in a grain of sand, but it will not always reconcile neatly with the eternity one perceives in an hour. To live in the moment, abandoning the norms and restrictions imposed by society, might apparently show the way to some deeper insight, but it is not necessarily the same insight one might perceive if one is attempting to understand the grander temporal structure underlying that moment.

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14 Compare Siegel (53–54) with Herman and Weisenburger (77–81) on this point.

Conclusion

Much more might be (and has been) said on the book's temporality, of course. Regardless, though, I believe these methods draw our attention to aspects of its treatment in the text that are not easy to perceive when reading traditionally, given the book's immense length and complexity. The book's temporal pyrotechnics are rooted in its use of tense, its minor character interactions, and its high-frequency words, none of which are easy to consciously perceive while grappling with the novel's larger challenges. Using digital methods does not so much carry our criticism into entirely different territory, then, as it allows subtler ways of addressing the subjects in which we have always been interested: rather than being close reading's opposite, distant reading can assist it. The data presented in this article, then, might provide a basis on which further work might proceed and be substantiated. And, of course, it far from exhausts the possibilities of digital analysis. As more digital tools are developed, more approaches might be pioneered that might address other questions we have long pursued, as well as ask ones we have not yet thought to ponder.

<div align="right">David Letzler, Independent Scholar</div>

Supplementary Files

The supplementary files for this article can be found as follows:

- **Supplementary File 1:** XML file. http://dx.doi.org/10.16995/orbit.131.s1

Competing Interests

The author declares that they have no competing interests.

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